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1604832

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(54) APPARATUS FOR FILTERING FLUIDS

(71) We, FRAM CORPORATION, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 105 Pawtucket Avenue, East Providence, Rhode Island, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to the filtration of fluids. More particularly, but by no means exclusively, the invention relates to oil filtration, for example in motor vehicles.

Replaceable filter elements of the "outside-in" flow type are well known and usually comprise a body of filter material retained in an annular cylindrical configuration by means of inner and outer cylindrical sleeves and axial end caps. The inner and outer sleeves are usually perforated. For oil filtration, the filter material will usually comprise a quantity of fibrous filter medium.

In one form of filter commonly encountered, and known as a filter of the "bowl-and-bolt" type, a replaceable filter element of the above described type is retained in proper location within a generally cylindrical filter casing having a closed bowl-shaped end by means of a retainer seat biased by a spring away from the bowl-shaped closed end which urges the filter element axially towards and against a filter mounting casting provided with inlet and outlet passages for flow of fluid to and from the filter. The filter casing is mounted to the filter mounting casting by means of a bolt which extends axially through the casing, retainer seat and filter element and into a female socket in the casting.

In an alternative arrangement which allows for oil filter element replacement in keeping with modern quick servicing techniques, the filter element is mounted within an interchangeable filter cartridge which has a generally cylindrical casing with a generally bowl-shaped closed end, the other end of the filter casing being partly closed by means of a plate extending thereacross and provided with a central threaded aperture which both provides an outlet for filtered oil from the cartridge and enables the cartridge to be threaded on to a co-operating filter mounting casting. Radially outwardly of the central opening the plate is provided with one or more further apertures which provide an inlet to the cartridge for oil to be filtered.

Whether the filter is of the bowl-and-bolt type or of the cartridge type, it is usually adapted for full-flow filtration. In other words, the entire fluid flow from inlet to outlet is caused to pass through the filter element. In so-called "parallel-flow" filtration, two filter elements, usually employing different filter material, are mounted, usually in axial alignment, within the same filter casing. The arrangement is such that at the commencement of use of the filter, the major part of the fluid flow is through one of the filter elements, the other element only passing a minor proportion of the fluid. As the first filter becomes clogged with dirt extracted from the fluid, an increasingly greater proportion of the fluid flow is caused to pass through the other filter. This parallel-flow arrangement is not considered very advantageous because in order for the pressure drop across the filter as a whole not to become unacceptably high in the second stage of utility of the filter, either the second filter element has to be such as to allow a substantial proportion of dirt to pass therethrough unfiltered, or alternatively, a by-pass valving arrangement has to be incorporated to ensure that a proportion of unfiltered fluid is enabled to by-pass the filter elements and to pass directly from inlet to outlet.

It has long been appreciated that a reduction in engine wear would result if a highly efficient by-pass filter could be employed in addition to the normal full-flow filtration of engine oil, but until now there has been no satisfactory way in which this could be conveniently accomplished. We have sought to devise embodiments of filter in convenient and practical forms capable of obtaining this advantage. As we shall explain, in our embodiments, in addition to the usual full-flow filtration, we abstract a proportion of the filtered oil flow, further filter it in a by-

pass element and pass it directly to the sump. It should, however, be understood that the utility of our embodiments is not restricted to the filtration of oil.

In accordance with a first aspect of the present invention, we provide apparatus for filtering fluids comprising: a generally cylindrical outer casing; and end fitting at one axial end thereof, being coupled thereto, and providing an inlet for fluid to be filtered and separate outlets for passing filtered fluid to two separate destinations; and first and second filter elements each of generally cylindrical external configuration, and each comprising filter material disposed between opposed axial end caps, the first and second filter elements being mounted within the casing with their axes aligned with the axis of the casing such that one said destination receives fluid which has been filtered by the first said filter element and such that fluid received by the other said destination has been filtered by both of the said filter elements.

In a second and alternative aspect of this invention, there is provided apparatus for filtering fluids consisting of an interchangeable and replaceable filter cartridge adapted for use with a filter mounting, and comprising: a generally cylindrical cartridge casing closed at one end, the other end of the cartridge casing being partly closed by means extending thereacross and being provided with a central opening, and with one or more further openings radially outwardly of said central opening and arranged to receive fluid to be filtered; means for receiving and locating within said central opening a spigot or like means of a filter mounting to which said cartridge is adapted to be mounted, whereby said central opening is adapted to provide respective outlets for fluid to two separate destinations; and first and second filter elements mounted within said cartridge casing such that in operation one said destination is arranged to receive fluid filtered by the first said filter element and the other said destination is arranged to receive fluid filtered by both of said filter elements.

According to a third alternative aspect thereof, this invention provides apparatus of the bowl-and-bolt type for filtering fluids, comprising: a filter mounting provided with an inlet port for fluid to be filtered, and first and second outlet ports for passing filtered fluid to respective first and second destinations; a generally cylindrical casing open at one end, the other end being generally bowl-shaped and having a central aperture on the axial centre line of the casing but otherwise closed; a bolt coupling the casing to the mounting, being received through said central aperture with its shank extending along said axial centre line and its shank threadedly engaged in the mounting, the shank having at least one aperture in the side thereof communicating with a passage in said shank extending from said aperture and opening at said shank end into said mounting, and the mounting providing passage between said shank end and the second outlet port; and first and second annular filter elements each comprising a quantity of filter material disposed between opposed axial end caps, and being mounted within the casing, with the bolt extending through the central spaces of both thereof, such that the first filter element is arranged to filter incoming fluid to the filter and to pass a proportion of the fluid so filtered to the first outlet port and such that the second filter element filters only the remainder of the fluid filtered by the first filter and passes fluid so filtered to said shank aperture and thus to the second outlet port.

When the invention is embodied in a filter of the bowl-and-bolt type, the bolt may be hollow and may provide a passage for fluid filtered by one of the filter elements to pass to its respective destination. In the case of a cartridge, fluid flow from one of the filter elements to its respective destination may be by a one piece moulding which acts both as a separator tube and a locating means for the filter elements within the cartridge, which provides any necessary restriction in the flow, and which is adapted to receive internally a self-engaging spigot seal provided at the distal extremity of a spigot fitted in the filter mounting casting and providing separation therein between the two outlet destinations. Descriptions of both these arrangements are given below.

Various other arrangements are possible within the general scope of this invention, and several such arrangements are also described in detail hereinafter.

The invention is hereinafter more particularly described by way of example only with reference to the accompanying drawings, in which:—

Fig. 1 shows an axial sectional view of a first embodiment of filter in accordance with this invention, of the cartridge type;

Fig. 2 shows a modification of the first embodiment;

Fig. 3 shows a similar axial sectional view of a second embodiment of filter constructed in accordance with this invention, also of the cartridge type;

Fig. 4 shows a similar axial sectional view of a third embodiment of filter constructed in accordance with this invention, being of the "bowl-and-bolt" type;

Figures 5, 6 and 7 are views of embodiments respectively similar to those of Figs. 1, 3 and 4, but which each employ a unitary filter media cartridge in place of separate elements;

Fig. 8 shows another embodiment of filter in accordance with this invention and of the

cartridge type, partly in section;

Fig. 9 shows an axial sectional view of one half of a further embodiment of filter of the bowl-and-bolt type in accordance with the invention, the other half being similar; and

Fig. 10 shows a further embodiment of bowl-and-bolt filter in accordance with this invention in axial section.

The cartridge generally indicated 1 in Fig. 1 comprises a generally cylindrical casing 2 having a bowl-shaped closed end 3, the other end of the casing being partially closed by means of a plate 4 having a series of apertures 5 providing inlets to the filter cartridge and a central threaded female aperture 6. Alternatively, an externally or male threaded spigot (not illustrated) may be provided in place of the central threaded aperture, for reception in a threaded socket. Mounted within the casing are filter elements 7 and 8 respectively located in position by a flow separation means in the form of a one-piece moulded locating and separating tube 9 and a retainer spring 10 as illustrated (or some alternative biasing arrangement) at the closed end 3 of the casing. The two filter elements 7, 8 are shown axially aligned, being annular cylindrical in configuration, having their respective filter media 7*a*, 8*a* disposed between opposed annular axial end caps 7*b*, 7*c* and 8*b*, 8*c* respectively. Each filter medium may consist of a body of fibrous filter medium or of a pleated paper annulus in accordance with the usual practice in this art. However, we prefer to use, at least for the filter element 8, a fibrous filter medium.

The co-operating filter mounting casting 11 has an inlet passage 12 and first and second outlet passages 13 and 14 respectively. The inlet passage 12 and the first outlet passage 13 would be coupled into the engine oil circuit in the usual way, whereas the second outlet passage would in use be coupled directly to the sump. In order to couple the cartridge 1 to the filter mounting casting 11, an externally threaded tube section 15 is provided in this embodiment, as shown, and a spigot 16 provided with an external seal ring 17 adjacent its distal end is fitted in the filter mounting casting 11. The cartridge 1 is provided in conventional fashion with a sealing ring 18 mounted in a metal locating ring 19 which is attached to the plate 4, as by welding, and folded into a seam with the adjacent edge of the casing 2. As shown, filter element 8 is located relative to the separator tube 9 by means of a flexible seal 20 which ensures that all outgoing filtered fluid from filler element 8 passes to outlet 14.

In operation of the filter as so described, dirty fluid will arrive in the inlet passage 12, pass into the cartridge through the inlet apertures 5 and then pass through the first filter element 7 in outside-in flow, and thence via a plurality of apertures 21 in the separator tube 9 into the space between tube section 15 and spigot 16 and thence to the first outlet passage 13. In order for the first and second filter elements to operate in tandem so far as the by-pass flow is concerned, the external cylindrical shell 22 of filter element 8 is unperforated and its end cap 8*b* is provided with perforations as at 25 so that filter element 8 receives a proportion of the fluid already filtered by passage through filter element 7.

The cartridge of Fig. 2 is generally similar to that of Fig. 1, except that its filter element 8′ is modified to make use of part of central space 23, having a central well in each axial end cap, that in end cap 8′*b* being of greater depth than that in end cap 8′*c* in order to accommodate the end portion of separator tube 9, and being provided with perforations at 26 to allow passage of filtered fluid from filter medium 8′a into what remains of central space 23.

As indicated in dashed lines 27 in Fig. 1, a conventional anti-drain valve arrangement may be provided adjacent the inlet apertures 5 of filter cartridge 1, the separator tube 9 again providing a locating facility. A cartridge relief valve, for example as described with reference to Figs. 7 to 10 of the Complete Specification of Application No. 7705/79 Serial No. 1604831, from which the present application has been divided, may also be incorporated.

Alternatively, a conventional cartridge relief valve assembly may be employed, being coupled, for example to the central portion of retainer 10; but in this case the roles of the two filter elements 7 and 8 must be reversed, as in the modified arrangement of Fig. 3. In this arrangement, it is the second filter element 8 which provides the conventional full-flow filtration by outside-in flow to central space 23, from whence filtered fluid passes via a relatively unrestricted opening 24′ into separator tube 9′, along the axial length of the interior of separator tube 9′ and spigot 16 into the second outlet passage 14 which would be coupled into the engine oil circuit. End cap 7*c* of filter element 7 is provided with a plurality of perforations as at 29, shell 28 being unperforated. End cap 7c may be recessed, as shown at 30, to facilitate flow of part of the fluid already filtered by passage through filter element 8 into perforations 29.

Cartridge relief valve assembly 31 is of a conventional form, having a valve member 31*a* biased by a spring 31*b* to normally close a relief aperture 31*c*. Spring 31*b* is retained in position by a perforated valve housing 31*d*. Excess pressure on the inlet side of the filter of Fig. 2 will cause the valve member 31*a* to leave its valve seat allowing unfiltered fluid to by-pass filter element 8.

The embodiments of Figs. 1 to 3 may be

modified as shown in Fig. 11 of the Complete Specification of Application No. 7705/77. Serial No. 1604831.

All parts in the bowl-and-bolt filter of Fig. 4 which are generally similar in construction and/or operation to similar parts of the embodiment of Fig. 1 are shown with the same reference numeral as in Fig. 1 but increased by 100—so that, for example, filter element 107 of Fig. 4 is equivalent to filter element 7 of Fig. 1. The main difference between the two arrangements is that in the embodiment of Fig. 4 the shank, here indicated 3, of bolt 33 is formed as a tube or otherwise provided with an axial passage for receiving fluid filtered by the second filter element 108 and with apertures 34. The distal end of bolt 33 opens out into a passage 35 which provides the second outlet passage in filter mounting casting 111 of this embodiment. Operation of the filter of Fig. 4 is otherwise the same as for the embodiment of Fig. 1, end cap 108*b* being perforated at 125 while shell 122 is unperforated.

Fig. 5 shows an embodiment of filter cartridge generally similar to that of Fig. 1 but in which the filter elements 7 and 8 are combined into a single unitary filter media cartridge 36. Cartridge 36 has one-piece outer cylindrical sleeve 37 which provides the outer sleeve for both filter elements, and opposed external end caps 38 and 39 at its opposite axial ends and an intermediate internal annular partition 40. End caps 38, 39 of the cartridge and partition 40 may replace the individual end caps of elements 7 and 8 or supplement them. It will be noted that the seal 20 is carried by partition 40. To provide tandem flow, the part of sleeve 37 against filter element 8 is unperforated and apertures such as 25 are employed as described in connection with Fig. 1.

Fig. 6 shows the use of the unitary filter media cartridge concept in an arrangement otherwise similar to Fig. 3. Like reference numerals are used for like parts. It will be noted in Fig. 5 that filter element 8 retains its individual end caps 8*b* and 8*c* while filter element 7 relies upon external end cap 38 and internal partition 40 for its end caps.

The unitary filter media cartridge concept can also be applied to a bowl-and-bolt type filter, as illustrated by Fig. 7 which is otherwise similar to Fig. 4, like reference numerals being used for like parts in Figs. 4 and 7; parts similar to parts of Fig. 5 being identified by numerals increased by 100.

The embodiments described hereinabove may be unacceptable for certain applications since if the filter is intended to replace an equivalent filter with substantially the same full-flow filtration capability, the addition of the second filter element for by-pass flow will in general add to the axial extent of the filter. Usually this will not matter greatly, but for engine compartments in which space is at a premium we have devised three further arrangements, one of the cartridge type (Figs. 8) and two of the "bowl-and-bolt" type (Figs. 9 and 10), in which both filter elements are accommodated in the axial space which would normally be required for the equivalent full-flow filter element itself.

Fig. 8 uses like reference numerals to Fig. 1 for like parts, but increased by 200—so that, for example, filter element 207 of Fig. 8 is equivalent to filter element 7 of Fig. 1.

The second filter element 208 is centrally disposed within the space available on the internal or clean side of the first filter element 207 and comprises a body 208*a* of fibrous filter material packed within a capsule 41 which in this illustrated arrangement is conveniently formed of plastics material and has a generally cylindrical external configuration. Second filter element 208 has opposed axial end caps 208*b* and 208*c* respectively located by a shoulder 42 and an internal edge portion 43 of capsule 41. Capsule 41 has an integral flange 44 enabling it to be located and firmly held between end cap 207*c* of filter element 207 and retainer spring 210. In order to allow for location of spigot 216, the capsule 41 is provided in the illustrated arrangement with an integral frusto conical extension piece 45 provided with a spigot seal 46. Alternatively, the seal may be formed on the spigot, or, if the spigot is of greater axial extent, within capsule 41. The cartridge may be provided with a cartridge relief valve assembly, such as that shown at 47. The illustrated relief valve assembly has a housing in two parts 48 and 49, each formed of plastics which are a snap-fit together, flange 50 of housing part 48, together with the outer circumferential edge portion 51 of annular valve member 52 fitting into annular groove 53 of housing part 49. A compression spring 54 mounted within housing part 48 via an annular spring plate 55 biases the annular valve member 52 against its seat on the confronting end portion of housing part 49. When the differential pressure across the filter becomes sufficiently large annular valve member 52 will be forced from its seat to allow unfiltered fluid from inlet apertures 205 directly to the space between tube section 215 and spigot 216. An antidrain valve member 56 is also shown in Fig. 8 its inner annular edge being trapped between housing part 48 and end cap 207*b* of filter element 207.

A portion of the fluid filtered by passage through full-flow filter element 207 passes through openings 57 in relief valve housing part 48 and thence to an outlet, which in engine oil filtration would be coupled in to the engine oil circuit, via the space between tube section 215 and spigot 216. The cylindrical side wall 59 of capsule 41 is perforated so

that a portion of the fluid already filtered by passage through filter element 207 is further filtered in element 208 before discharge through perforations 58 in end cap 208*b* into the interior of frusto conical extension piece 45 and thence to its destination (such as the sump in engine oil filtration) by passage along the interior of spigot 216. As in the previously described embodiments a restrictor may be required on the outlet side of element 208. A suitable restrictor is shown mounted at 60 in the interior of spigot 216. Alternatively the restrictor may be provided by a suitably sized hole at the centre of a restrictor plate (as shown in dotted lines at 60*a*) mounted within capsule 41.

In Fig. 9, in which like reference numerals to Fig. 4 are employed for like parts—but with the addition of 200—so that filter element 307 of Fig. 9 is equivalent to filter element 107 of Fig. 4, the second filter element 308 is mounted coaxially within first filter element 307. The opposed axial end caps 308*b* and 308*c* of filter element 308 form part of a plastics housing or capsule 61. Fluid to be filtered by element 308, being part of the fluid already filtered by element 307 passes into the element 308 via perforations 62 in external cylindrical shell 322. Filtered fluid passes out of element 308 via perforations 63 on its inner cylindrical shell, and thereafter via perforations into the interior of bolt 233. A frusto conical extension piece 64 joined to or integral with housing or capsule 61 with a seal 65 at its inner periphery cooperating with bolt 233 separates the fluid at the outlet side of filter elements 307, 308 for passage to the respective destinations. As illustrated in Fig. 9, the element 308 tapers slightly from one axial end to the other but still has a configuration which is generally cylindrical.

We consider the arrangement of Fig. 10 to be particularly advantageous since it provides for by-pass flow without adding to the axial extent of the filter and also without greatly adding to the difficulties of fabrication. The filter of Fig. 10 is of the bowl-and-bolt type. The reference numerals used correspond in general to those used in Fig. 4, but with the addition of 300. Thus, filter element 407 of Fig. 10 is generally equivalent to element 107 of Fig. 4. The filter means of Fig. 10 is of generally cylindrical external configuration and has a one-piece outer cylindrical sleeve 66, being the outer perforated sleeve of element 407. A portion of the fluid filtered by element 407 passes through apertures 67 in a plate 68 (which may be formed integrally with end cap 407*b*) and which carries an annular sealing ring 69 which seals incoming fluid in passage 412 from outgoing fluid in passage 413 which has been filtered by element 407. The other end of element 407 is supported on an end locating plate 70 via an intermediate sealing ring 71 which is carried by a plate which corresponds to plate 68 at the opposite axial end of element 407 and is suitably formed integrally with end cap 407*c*. The end locating plate 70 is biased away from the closed bowl end by the compression spring provided about the bolt. Part of the fluid already filtered by element 407 is further filtered in element 408 (also by outside-in flow) and then passes via aperture 334 into the interior of shank 332 of bolt 333 and thence to outlet passage 335. The end caps 408*b* and 408*c* of element 408 each carry a seal 72. It will be noted that element 408 is not fixed to any other parts but is freely slidingly received on shank 332 via its seals 72. This greatly aids fabrication since element 408 does not require precise location, but may simply be slipped over the end of shank 332 during assembly of the parts, being essentially self-locating or centering.

Reference should be made to the Specification of our copending Patent Application No. 7705/77 (Serial No. 1604831) from which the present application has been divided, to the Specification of our copending Patent Application No. 24888/78 (Serial No. 1604833) also divided from Application No. 7705/77 and to the Specification of our copending Patent Application No. 8102598 (Serial No. 1604834) divided from Application No. 24888/78, each of which include matter common to the present specification.

WHAT WE CLAIM IS:—

1. Apparatus for filtering fluids comprising: a generally cylindrical outer casing; an end fitting at one axial end thereof, being coupled thereto, and providing an inlet for fluid to be filtered and separate outlets for passing filtered fluid to two separate destinations; and first and second filter elements each of generally cylindrical external configuration, and each comprising a quantity of filter material disposed between opposed axial end caps, the first and second filter elements being mounted within the casing with their axes aligned with the axis of the casing such that one said destination receives fluid which has been filtered by the first said filter element and such that fluid received by the other said destination has been filtered by both of the said filter elements.

2. Apparatus according to Claim 1, wherein the generally cylindrical outer casing consists of the generally cylindrical cartridge casing of an interchangeable and replaceable filter cartridge; and wherein the said end fitting consists of a filter mounting to which the cartridge is threadedly coupled.

3. Apparatus for filtering fluids consisting of an interchangeable and replaceable filter cartridge adapted for use with a filter mounting, and comprising: a generally cylin-

drical cartridge casing closed at one end, the other end of the cartridge casing being partly closed by means extending thereacross and being provided with a central opening, and with one or more further openings radially outwardly of said central opening and arranged to receive fluid to be filtered; means for receiving and locating within said central opening a spigot or like means of a filter mounting to which said cartridge is adapted to be mounted, whereby said central opening is adapted to provide respective outlets for fluid to two separate destinations; and first and second filter elements mounted within said cartridge casing such that in operation one said destination is arranged to receive fluid filtered by the first said filter element and the other said destination is arranged to receive fluid filtered by both of said filter elements.

4. Apparatus of the bowl-and-bolt type for filtering fluids, comprising: a filter mounting provided with an inlet port for fluid to be filtered, and first and second outlet ports for passing filtered fluid to respective first and second destinations; a generally cylindrical casing open at one end, the other end being generally bowl-shaped and having a central aperture on the axial centre line of the casing but otherwise closed; a bolt coupling the casing to the mounting, being received through said central aperture with its shank extending along said axial centre line and its shank threadedly engaged in the mounting, the shank having at least one aperture in the side thereof communicating with a passage in said shank extending from said aperture and opening at said shank end into said mounting, and the mounting providing passage between said shank end and the second outlet port; and first and second annular filter elements each comprising a quantity of filter material disposed between opposed axial end caps, and being mounted within the casing, with the bolt extending through the central spaces of both thereof, such that the first filter element is arranged to filter incoming fluid to the filter and to pass a proportion of the fluid so filtered to the first outlet port and such that the second filter element filters only the remainder of the fluid filtered by the first filter and passes fluid so filtered to said shank aperture and thus to the second outlet port.

5. Apparatus according to any preceding claim, wherein the first and second filter elements are mounted coaxially within said casing such that the second said filter element is at least partially received within the first.

6. Apparatus according to both Claim 4 and Claim 5, wherein the first filter element is located within said casing by a compression spring mounted about said shank and bearing against the bowl-shaped end of the casing, the bias of said spring urging the first filter element axially towards the filter mounting; and wherein the second filter element is freely slidingly received on said shank, whereby the second filter element is self-centred during assembly of the apparatus.

7. Apparatus for filtering fluids substantially as hereinbefore described with reference to and as shown in Figures 1, 2, 4, 5 or 8 of the accompanying drawings.

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FIG.1.

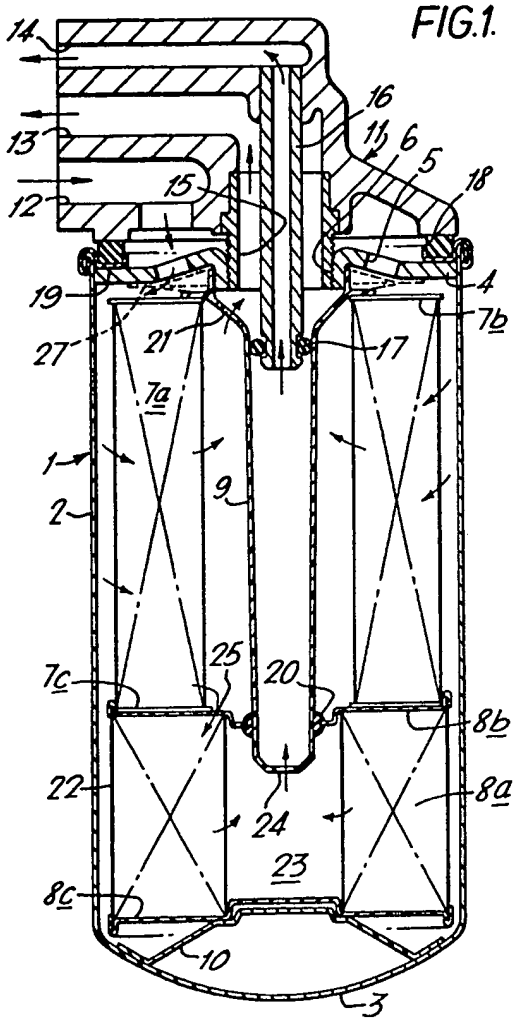


FIG.2.

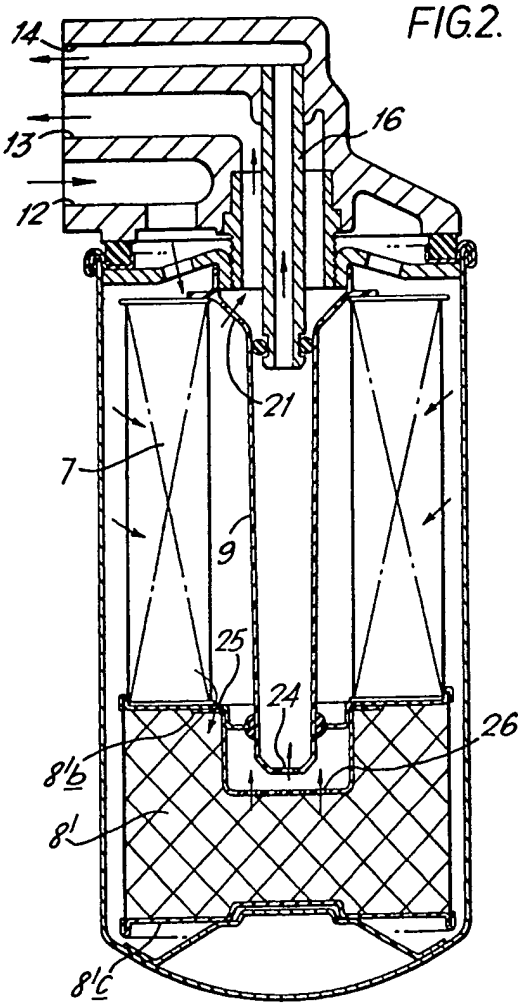


FIG.3.

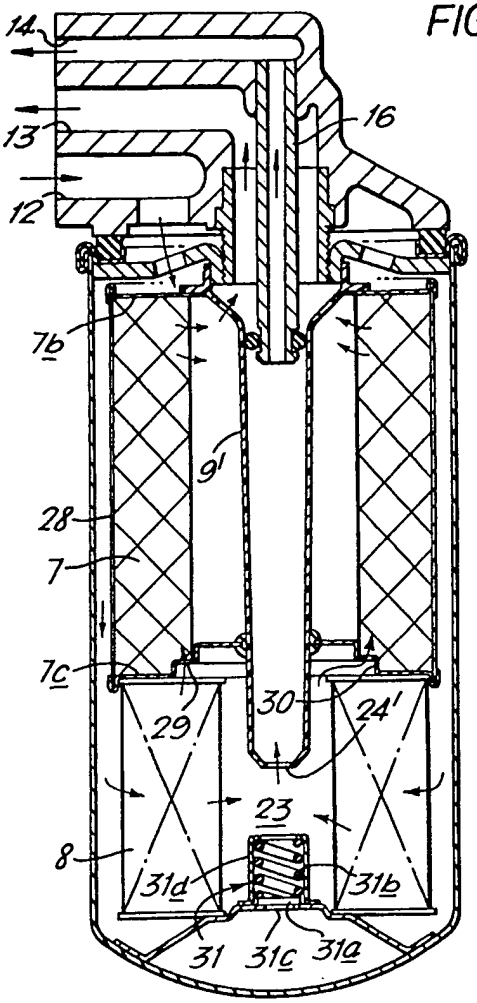


FIG.4.

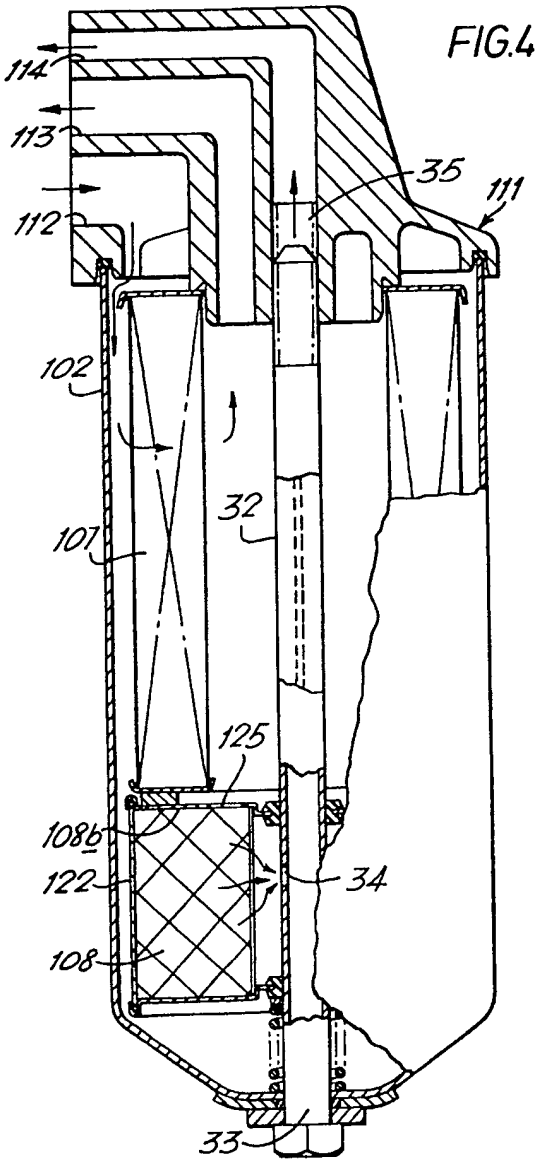


FIG.5.

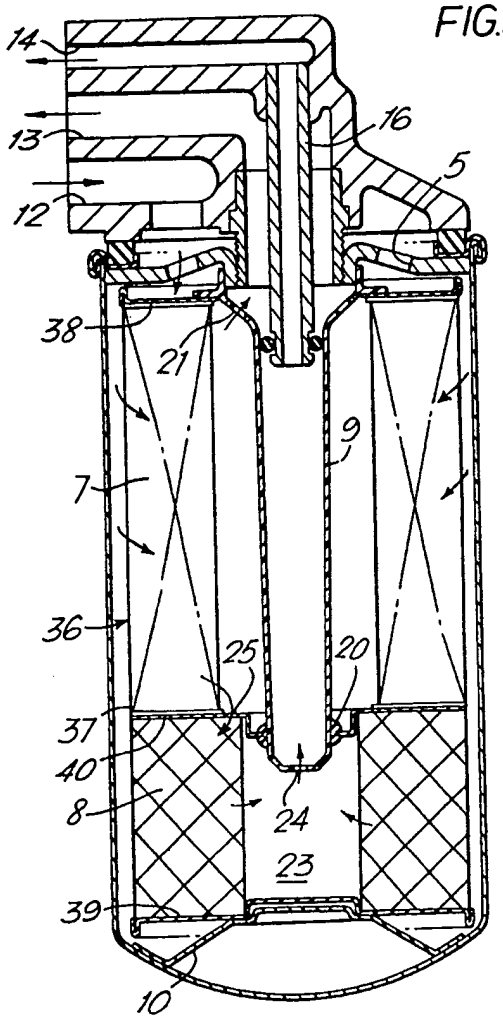
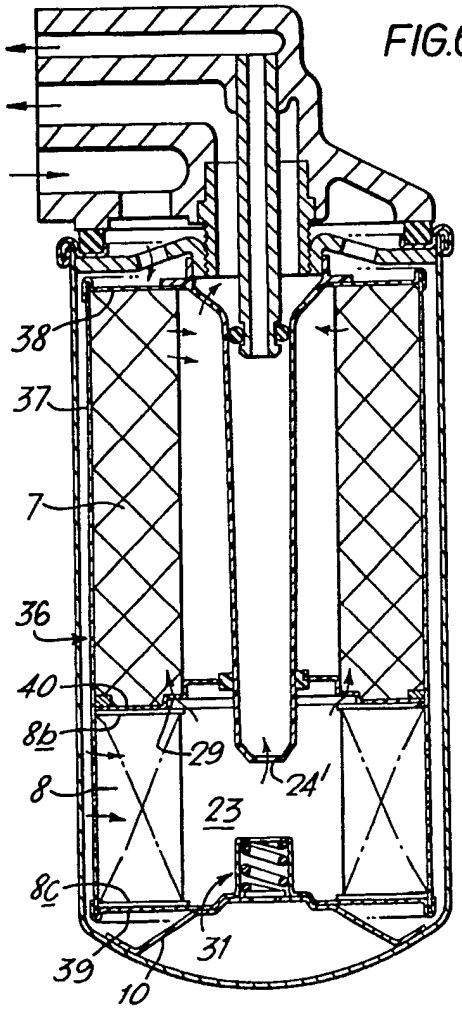


FIG.6.



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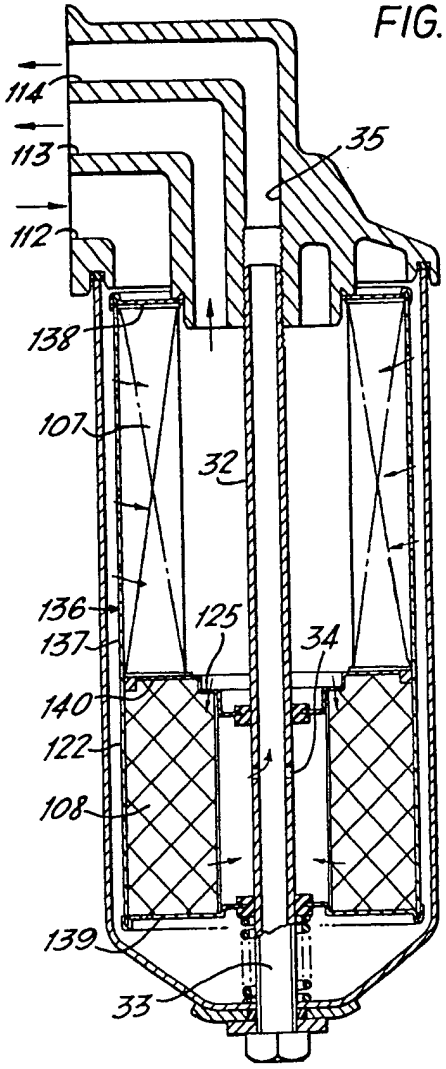

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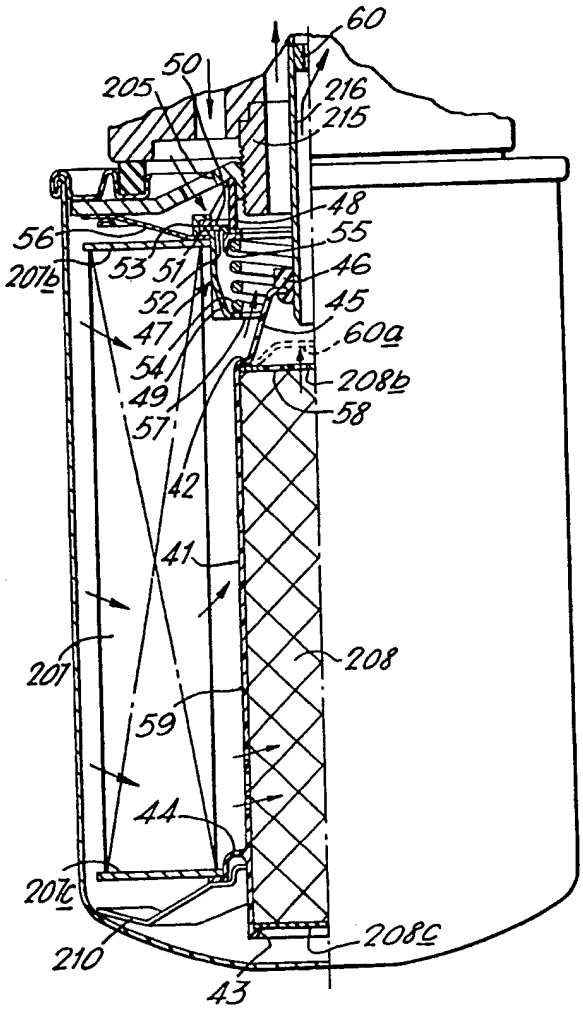
FIG.8.



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Sheet 9

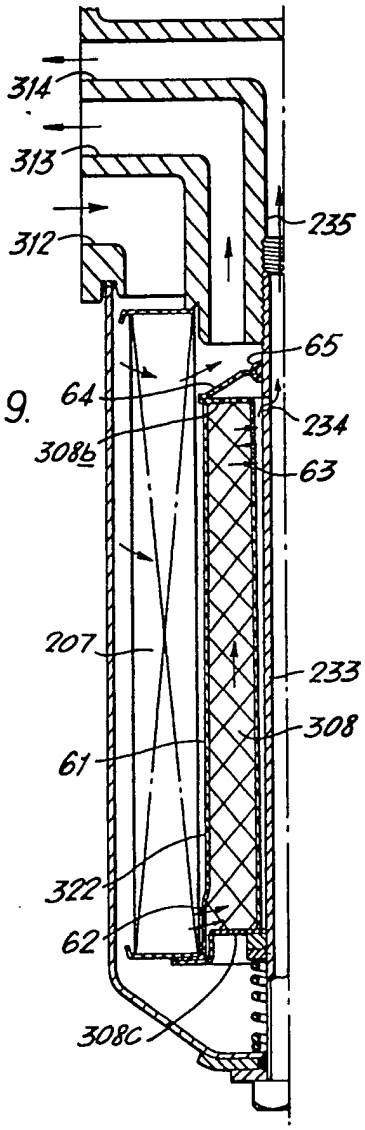
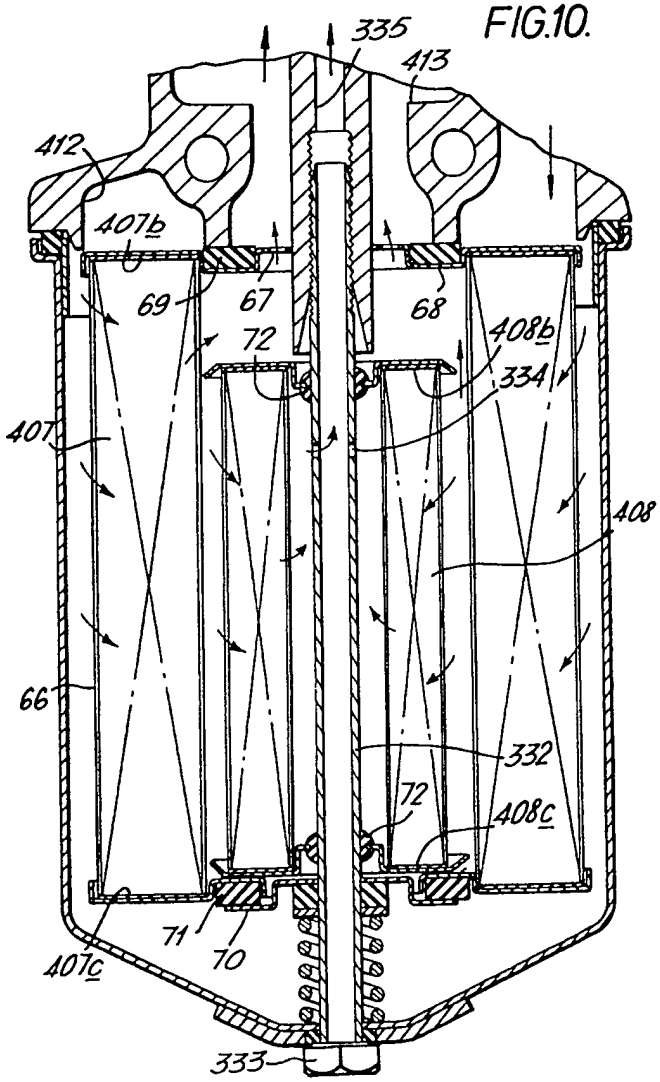


FIG.9.

FIG.10.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